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ENGELMANN SPRUCE

Engelmann spruce, one of the lightest of the important commercial woods in the United States, is soft, machines well, has low shrinkage and uniform color. The wood closely resembles that of the eastern spruces in appearance and properties, and like them has excellent pulping properties. The principal uses are in home construction—framing, sheathing, interior paneling, and exterior trim, etc.—and for plywood manufacture, food containers, and other specialty items including pulp and paper.

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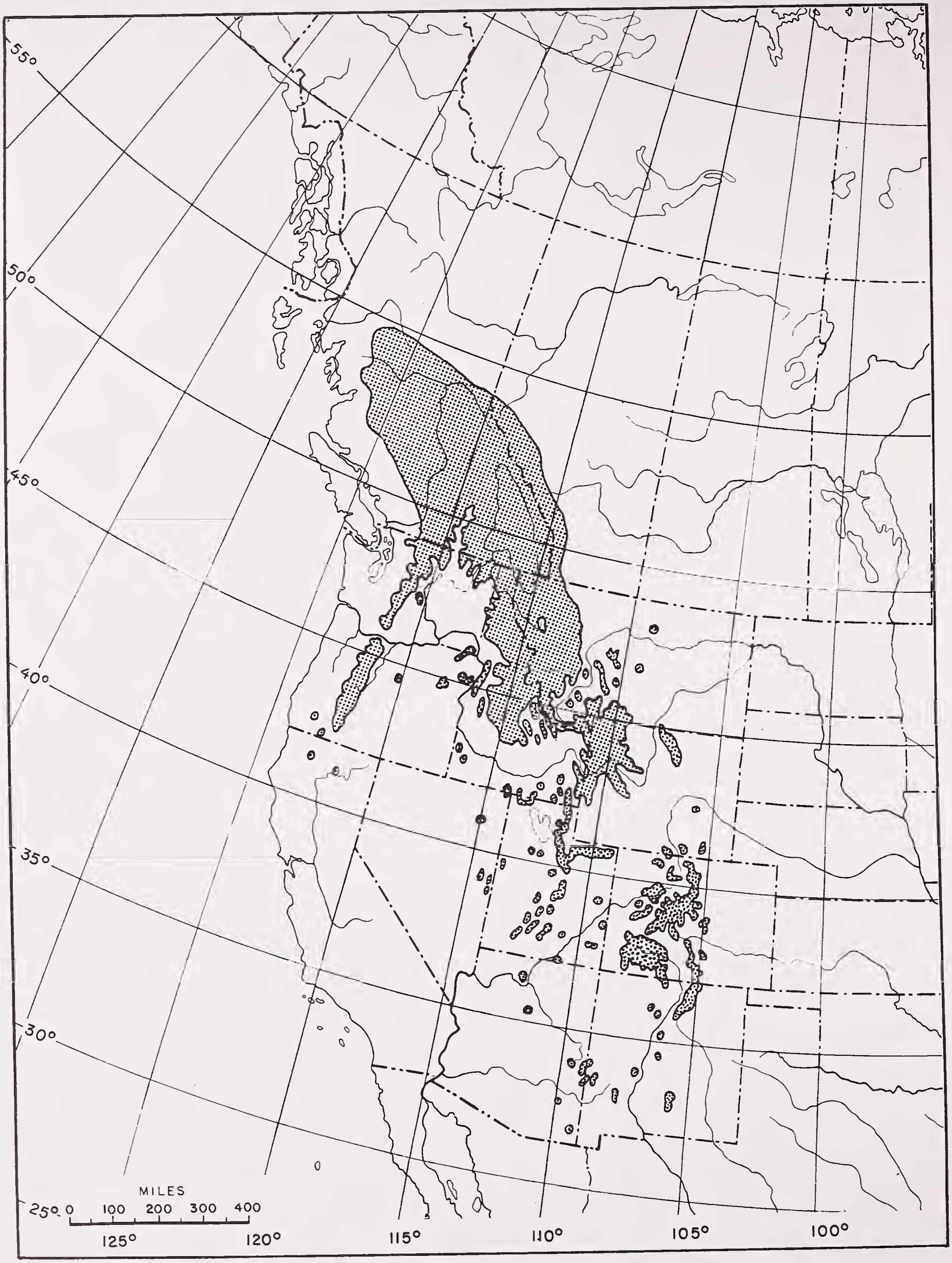

Figure 1.—Natural range for Engelmann spruce, *Picea engelmannii* Parry.

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ENGELMANN SPRUCE

(*Picea engelmannii* Parry)

George A. McSwain, Robert R. Alexander, and Donald C. Markstrom [1]

DISTRIBUTION

Extensive stands of Engelmann spruce are found at high elevations in the Rocky Mountains of nine Western States and two Canadian Provinces. Engelmann spruce is found in the Rocky Mountains of southwestern Alberta and central British Columbia, southward through Washington, Idaho, Montana, Oregon, western and central Wyoming, and in the high mountains of southern Wyoming, Utah, Colorado, Nevada, Arizona, and New Mexico (fig. 1). This species is a major component of the high-elevation forests of the Rocky Mountain region.

In the Pacific coast region, Engelmann spruce grows along the east slope of the coast range from west-central British Columbia, south along the east slope of the Cascades through Washington and Oregon, to Mount Shasta in northern California. This spruce is only a minor component of the high-elevation forests of the Pacific coast.

Engelmann spruce is found most typically in association with subalpine fir to form the Engelmann spruce-subalpine fir forest type. It also grows in mixture with species other than subalpine fir, where Engelmann spruce usually comprises over half the volume. Stands of mixed composition where spruce predominates are common throughout the Rocky Mountains. These stands occur from the headwaters of mountain streams near timberline to protected north and east slopes where soil moisture is sufficient near the lower limits of the growth of this species. Spruce grows in many kinds of stands from a few scattered trees near timberline to unbroken, dense forest below. This species does not normally grow in pure stands.

The elevations at which Engelmann spruce grows vary considerably throughout its range depending on local climatic and physiographic conditions. Engelmann spruce trees of merchantable size and form are found at intermediate and lower elevations but at timberline are commonly stunted. The amount of merchantable sawtimber that can be cut from typical stands containing Engelmann spruce varies from practically nothing at timberline to as much as 80,000 board feet per acre on the best sites.

DESCRIPTION AND GROWTH

Mature trees in a good environment are generally from 100 to 120 feet in height and from 18 to 36 inches in diameter. The largest on record is 19 feet 11 inches in circumference at breast height, 104 feet high, with a 30-foot crown spread.

The root system of Engelmann spruce is shallow but well developed. Mature trees have a number of large lateral roots generally less than 2 feet below the ground surface. These roots may extend 20 or more feet from the trunk. This extension enables the tree to survive on shallow soils but makes it dependent upon superficial soil moisture, susceptible to windthrow, and subject to root injury from surface fire. The thin bark is also easily injured by fire, which spreads readily through the dead, dry, flammable lower limbs and frequently to the crown. Fortunately, the season of high fire risk is comparatively short at the elevations where Engelmann spruce grows.

Engelmann spruce cones are usually 1 to 2½ inches long and have thin and somewhat papery, wedge shaped scales, commonly notched at the apex (fig. 2). Seeds are about ⅛ inch long, nearly black, with wings about ½ inch long. Needles are 1 to 1½ inches long, linear, four sided, blue green and often blunt at the apex. The bark is very thin and is broken into large purplish-brown to russet-red, loosely attached scales (fig. 3).

The tree is a moderate seeder, and the seed are viable over extended periods. Germination is usually good when moisture is available. The early growth of spruce is slow. Initial establishment and early growth are encouraged by shade and abundant moisture. Shade conserves moisture by reducing temperatures that cause water losses from both seedlings and soil. Shade also reduces light intensity, which at high elevations where spruce grows, can be so intense that it may injure or even kill new seedlings that start in the open. Engelmann spruce is more shade tolerant than any of its associates except the true firs, cedar, and hemlock; but mountain spruce forests do not commonly contain all age and size classes from seedlings to mature trees.

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[1] Principal wood technologist, U.S. Department of Agriculture, Forest Service, Washington, D.C.; principal silviculturist, and associate wood technologist, respectively, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, in cooperation with Colorado State University.

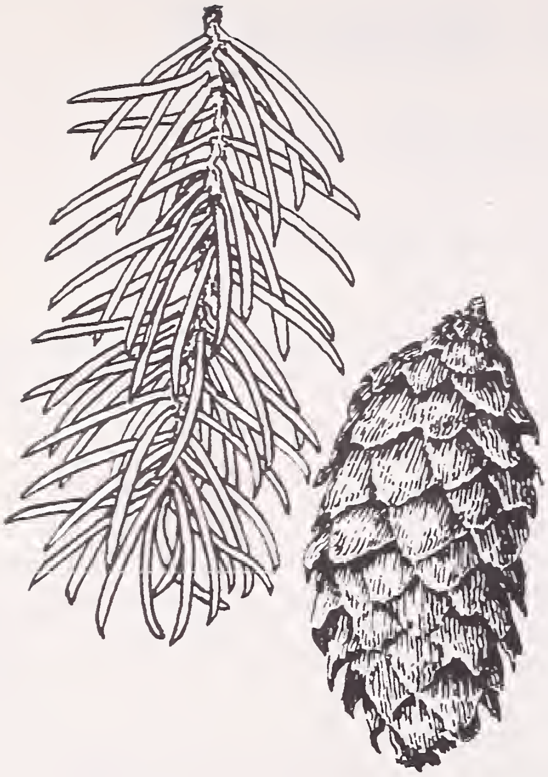

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Figure 2.—Needles and cone of Engelmann spruce.

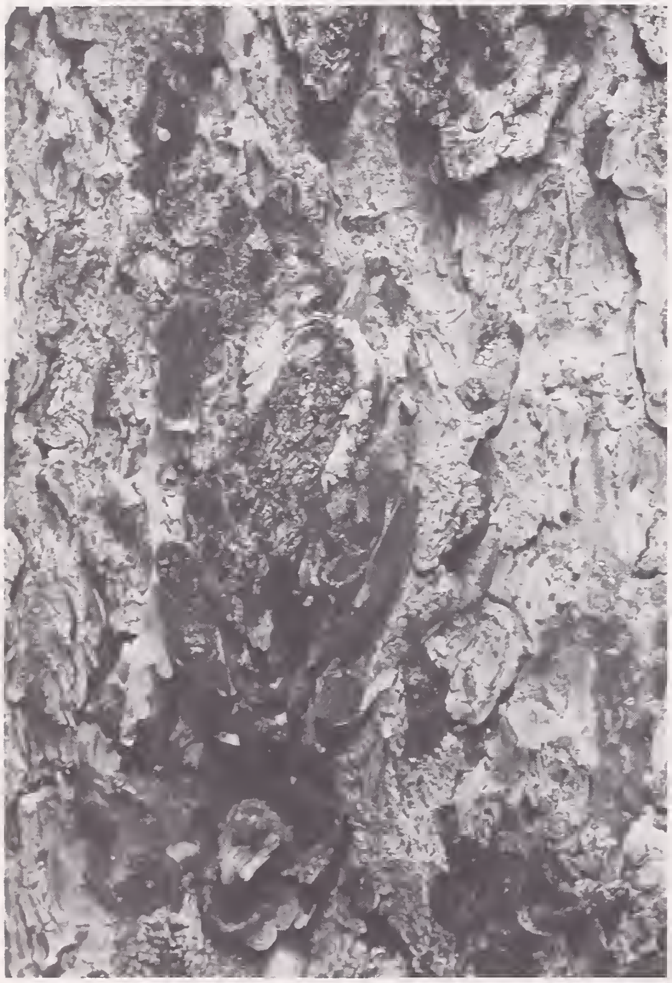

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Figure 3.—Bark of Engelmann spruce.

Old-growth stands are either even-aged, or two- or three-storied or broad-aged. These old stands frequently are not suitable for management of any kind. In bringing old stands under management, they should first be harvested. But residual understory trees and some logging slash must be left to provide shelter for new reproduction.

COMMON NAMES

Engelmann spruce is the name commonly used, but others are Columbian spruce, mountain spruce, silver spruce, and white spruce.

RELATED COMMERCIAL SPECIES

Blue spruce (*Picea pungens* Engelm.) is included in the reported totals of sawtimber and wood of Engelmann spruce. This species is found in the Rocky Mountain region, mostly in mountains of Colorado, Utah, Montana, Idaho, Arizona, and New Mexico.

SUPPLY

In 1963 the total stand of Engelmann spruce of sawtimber size in the United States was estimated at about 80 billion board feet.[2] About 52 percent of the total stand was in the southern Rocky Mountain region, about 40 percent in the northern Rocky Mountain region, and the remainder in the Pacific Northwest. Over one-third of the total stand was in Colorado. Montana and Idaho contained lesser quantities followed in decreasing order by Wyoming, Utah, New Mexico, Oregon, Washington, Arizona, and Nevada.

PRODUCTION

The production of Engelmann spruce lumber has fluctuated widely, but with a generally increasing trend from 1869 to the mid-1950's (fig. 4). It rose spectacularly between 1949 and 1956, from approximately 86 million board feet to a record of 795 million board feet. This marked increase reflected major efforts to salvage insect-killed timber during and immediately following a major bark beetle epidemic. Since 1956, production has been somewhat below this peak, and again it has been subject to considerable variation. In 1964 about 93 percent of the total lumber produced came from the Rocky Mountain region, principally Montana, Idaho, and Colorado. For the period from 1955–64, the average production of lumber was about 512 million board feet per year. In recent years, the average annual cut for all purposes is estimated at over 600 million board feet.

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[2] Includes a small amount of blue spruce.

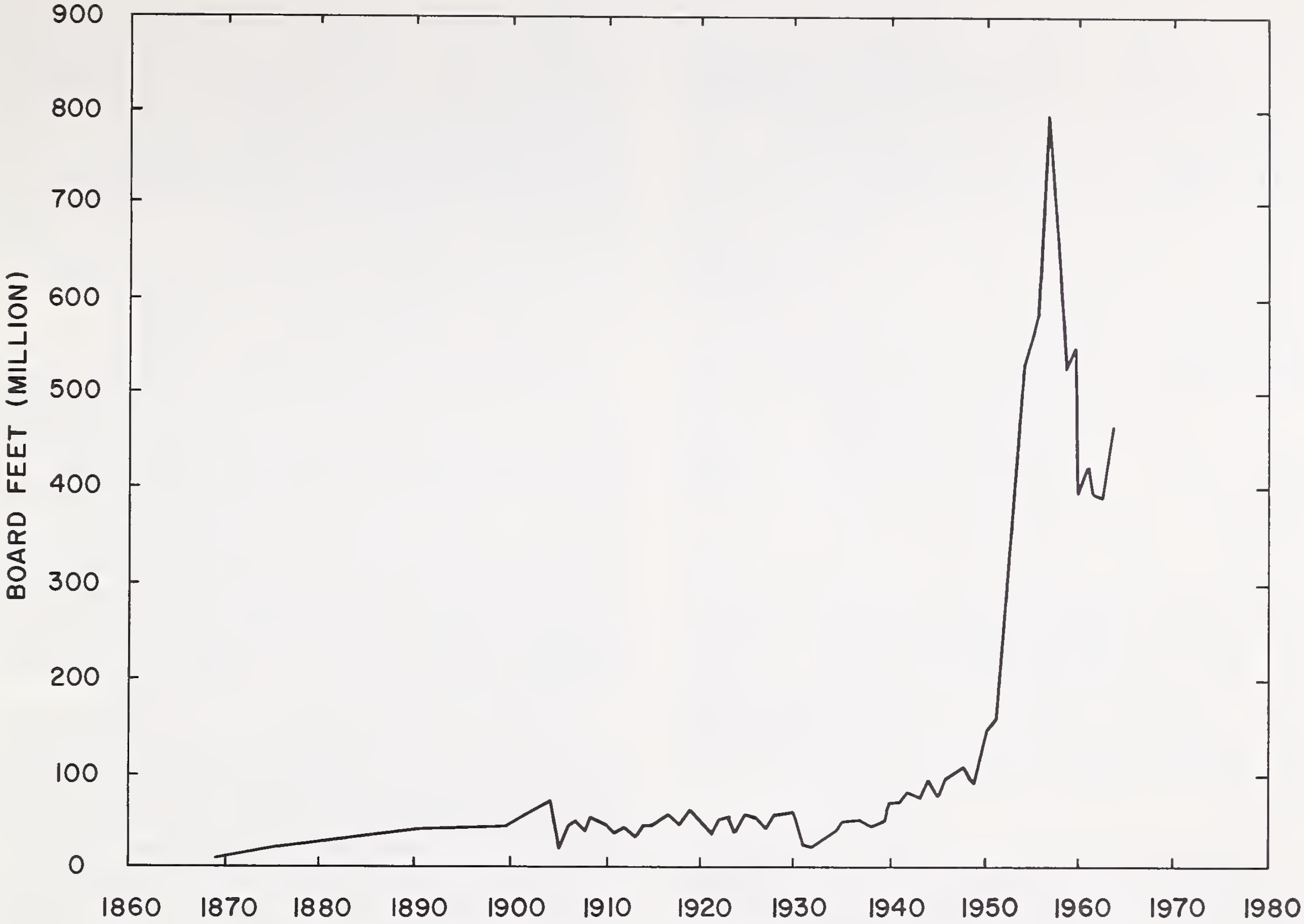

Figure 4.—Lumber production of Engelmann spruce, 1869–1964.

Old-growth Engelmann spruce is especially susceptible to devastating attacks by the spruce bark beetle. Heavy blowdowns in Colorado in 1939 and in Montana and Idaho in 1949 resulted in epidemic infestations that destroyed an estimated 9 million board feet of timber. This species is also subject to occasional attack by the spruce budworm. In some years, such attacks have caused considerable damage in several localities in the southern part of its range.

CHARACTERISTICS AND PROPERTIES

The heartwood of Engelmann spruce is nearly white, with an occasional slight tinge of red. The narrow sapwood, generally ¾ to 2 inches wide in trees of sawtimber size, is often difficult to distinguish from the heartwood but is commonly lighter. The annual growth rings are fairly distinct, with a marked difference in color between the summerwood and the springwood of the succeeding year. The transition from springwood to summerwood is gradual. The wood has a medium to fine texture. It has no characteristic taste or odor. Engelmann spruce contains resin ducts, but they are few and often visible only as white specks in the summerwood. Their presence distinguishes the wood of Engelmann spruce from that of white fir and other western true firs, which normally lack resin ducts but closely resemble Engelmann spruce.

The wood of Engelmann spruce is generally straight grained, has moderately small shrinkage, can be readily air dried, and is easy to work. When properly dried, it stays in place well. With a specific gravity of 0.32 based on ovendry weight and green volume, this species is one of the lightest important commercial woods of the United States. The average weight of air-dry Engelmann spruce (12-percent moisture content) is 24 pounds per cubic foot. The wood is rated low in beam and post strength and in its ability to resist shock, but it can be used in some construction where moderate strength is required. It has good nail-holding properties, is moderately limber, and is soft. If sufficient time is allowed, the lumber can be kiln-dried without difficulty.

In paint-holding properties, Engelmann spruce is classed with ponderosa pine and western hemlock—not as suitable as white pines, cedars, redwood, and cypress, but better than Douglas-fir and southern yellow pine.

Engelmann spruce, together with Sitka spruce and the eastern spruces, is among the woods that glue easily under a wide range of gluing conditions. The heartwood and sapwood are not durable when used under conditions favorable to decay. In this characteristic Engelmann spruce ranks with the hemlocks. The wood of Engelmann spruce is considered difficult to penetrate with a preservative, but properly incised crossties, pressure treated with creosote, have given satisfactory service.

The lumber is quite likely to contain many small knots formed by numerous small limbs, which persist for a long time, even near the base of a tree where shade is heavy. Consequently, the species yields only minor amounts of select grades of lumber, but a relatively high proportion of lumber in the common upper grades.

Engelmann spruce has excellent pulp and papermaking properties; ranking with the eastern spruces (white, red, and black) long used in the manufacture of paper pulp. Because it has long fibers, a relatively light color, and an absence of resin, it is readily pulped by the sulfite, sulfate, and groundwood processes. Both sulfite and sulfate processes produce strong papers of fine texture.

Sulfite pulp produced from Engelmann spruce has an excellent color and bleaches easily. Sulfate pulp also has satisfactory bleaching properties similar to those of white spruce. Sulfite pulp made from Engelmann spruce is suitable for the manufacture of newsprint, wrapping, book, high-grade printing, and bond papers; sulfate pulp is suitable for high-grade kraft wrapping papers and fiberboard.

Engelmann spruce also reduces readily by the groundwood process to yield a pulp of excellent color and standard strength suitable for practically all the uses requiring this type of pulp. The power required to operate the grinders when it is pulped by the groundwood process is about the same as required for white spruce.

While Engelmann spruce is less dense than the white and black spruce commonly used in the eastern paper industry, its lower density is offset by a relatively high solid volume of wood per cord because of its thin bark and straightness. Therefore, the yield of pulp per cord is about the same as from other spruces. The strength and brightness of papers made from Engelmann spruce are above average.

PRINCIPAL USES

In the past, Engelmann spruce was used principally for mine timbers, railroad ties, and poles. Minor amounts are still used in the central Rocky Mountain area for these purposes. Today, a principal use is for home construction, especially in the form of interior framing, wall sheathing, roof boards, shelving, subflooring, wall paneling, exterior trim, and other general millwork items. In recent years, rotary-cut veneer from Engelmann spruce has been used by plywood manufacturing plants in both the northern and southern Rocky Mountain areas.

The high strength-weight ratio of Engelmann spruce wood has made it particularly adaptable to specialty uses. In both World Wars, it was used somewhat for aircraft construction. For years it has been a choice wood for the manufacture of high-grade violins. Its resonance also makes it prized for other musical instruments, including pianos. In addition, large quantities are used for nailed wood boxes and shook, crates and prefabricated wood products, such as ironing boards, stepladders, snow fencing, water and snow skis, tanks, silos, and food containers. In lesser amounts, it is used for wood household furniture, especially kitchen furniture and in the manufacture of mattresses and bedsprings.

To date, Engelmann spruce has not been used widely for the manufacture of pulp and paper although the industry values it highly. At least one pulp and paper mill in the State of Washington uses this species, and increasing amounts are being shipped into the Lake States for this ultimate use.

REFERENCES

Alexander, R. R.
1958. Silvical characteristics of Engelmann spruce.* USDA Forest Serv. Rocky Mountain Forest and Range Exp. Sta., Sta. Pap. 31, 20 p., illus. Fort Collins, Colo.

Anderson, I. V.
1956. Engelmann spruce, its properties, uses, and production.* USDA Forest Serv. Intermountain Forest and Range Exp. Sta., Res. Pap. 39, 16 p., illus. Ogden, Utah.

Christensen, Earl M., and Hunt, Melvin J.
1965. A bibliography of Engelmann spruce.* USDA Forest Serv. Intermountain Forest and Range Exp. Sta. Res. Pap. 19, 37 p. Ogden, Utah.

Cowlin, R. W., Briegleb, P. A., and Moravets, F. L.
1942. Forest resources of the ponderosa pine region of Washington and Oregon. USDA Forest Service Misc. Pub. 490, 99 p., illus.

Drow, John T.
1960. Mechanical properties of Engelmann spruce.* USDA Forest Serv. Forest Prod. Lab. Rep. 1944–4 (rev.), 4 p., illus. Madison, Wis.

Gill, Thomas G.
1965. Wood used in manufacturing industries. USDA Forest Service Statist. Bull. 353, 121 p.

Harlow, William M., and Harrar, Ellwood S.
1958. Textbook of dendrology. Ed. 4, 561 p., illus. New York: McGraw-Hill Book Co., Inc.

Little, Elbert L., Jr.
1953. Checklist of native and naturalized trees of the United States (including Alaska). USDA Forest Serv. Agr. Handb. 41, 472 p.

Mueller, Lincoln A., and Barger, Roland L.
1963. Lumber grade recovery from Engelmann spruce in Colorado.* USDA Forest Serv. Rocky Mountain Forest and Range Exp. Sta. Res. Pap. 1, 23 p., illus. Fort Collins, Colo.

Ronco, Frank.
1961. Bibliography of Engelmann spruce and subalpine fir.* USDA Forest Serv. Rocky Mountain Forest and Range Exp. Sta., Sta. Pap. 57, 58 p. Fort Collins, Colo.

USDA Forest Products Laboratory.
1955. Wood handbook. USDA Forest Service Agr. Handb. 72, 528 p., illus.

———.
1956. Wood—Colors and kinds. USDA Forest Service Agr. Handb. 101, 36 p., illus.

USDA Forest Service.
1958. Timber resources for America's future. USDA Forest Service, Forest Res. Rep. 14, 762 p., illus.

———.
1965a. Silvics of forest trees of the United States. USDA Forest Service Agr. Handb. 271, 762 p., illus.

———.
1965b. Timber trends in the United States. USDA Forest Service, Forest Res. Rep. 17, 235 p., illus.

Western Pine Association.
1957. Engelmann spruce of the western pine region. Western Pine Assn., 48 p., illus.

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